ANDREW HANCOCK, PURDUE UNIVERSITY

Up Close With

Brad Duerstock

NEUROSCIENTIST, ASSISTIVE TECHNOLOGY DESIGNER

"The sense of discovery and the impact on others are big motivations for me."

HOBBIES

Gadgetry, architectural design

FAVORITE MUSIC

Rock and roll, bluegrass

HISTORIC FURNITURE

Revolving bookstand like the one Thomas Jefferson used at Monticello

BIZARRE COLLECTIBLE

Ecuadorian shrunken head (replica made from goatskin)

FAVORITE GENRES

History, science fiction

FAVORITE CUISINES

Mexican, Japanese


C500

ANDREW HANCOCK, PURDUE UNIVERSITY

Opening Up the Lab

Improving Access to Science for People with Disabilities

BY STEPHANIE DUTCHEN

A crash, then all goes black. When you come to, you can't feel part of your body. You will never move normally again.

Paralysis from accidents or medical conditions affects millions of Americans, forever changing their daily lives and future plans.

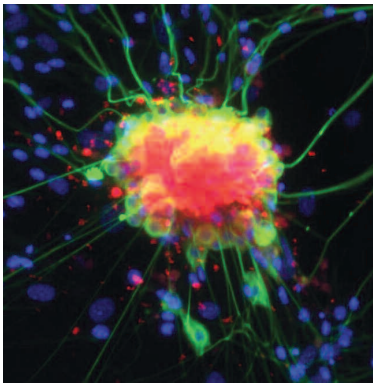
For those who want to work in labs, the road is being smoothed and widened by Brad Duerstock, a researcher at Purdue University in West Lafayette, Indiana.

Duerstock is building and modifying scientific equipment, adjusting the physical layout of labs and creating an online networking site. His goal is to encourage more people with impaired mobility or limited vision to pursue careers in science, technology, engineering and math fields.

"Science can be pretty inhospitable to people with disabilities. But that doesn't mean it's impossible," he says.

He speaks from experience. A quadriplegic since age 18 due to a spinal cord injury, Duerstock studies nerve injury and repair. Throughout his training and career, he's had to invent new ways to get the job done.

"It takes fortitude," he says. "You have to persevere. You have to be creative. You have to figure out your own solutions and make your own path."



LAWRENCE MARNETT, VANDERBILT UNIVERSITY

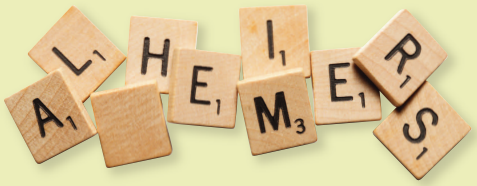
Spinal nerves (green) connect our skin and muscles to the spinal cord, allowing us to feel and react to our environment.

A New Path

Duerstock grew up in Indiana in a family of teachers and principals. An excellent student interested in science and medicine—and a star member of his high school's swim team—he planned to become a physician.

About 3 months before graduation, during a swim practice at school, he had a diving accident.

"It happened so fast. I don't even remember hitting my head and breaking my neck," he says. "All of a sudden, I was floating face down and couldn't move my body."



Does Cholesterol Play a Role in Alzheimer's?

Scientists have long known that cholesterol plays a number of roles—both good and bad—in the body. Now, they suspect it might also contribute to the development of Alzheimer's disease.

To visualize how this might happen, a team of researchers determined the structure of an Alzheimer's-related protein known as APP. To study the protein under normal conditions, the scientists placed it into laboratory-made membranes, which mimic its natural environment.

The scientists, led by Charles Sanders at Vanderbilt University Medical Center in Nashville, Tennessee, showed that APP can hook up with cholesterol in the artificial membranes. Based on other studies, the researchers believe that cholesterol then drives APP into specialized membrane areas known as lipid rafts. There, enzymes hack off pieces of APP, transforming it into a substance called amyloid beta, which accumulates in the brains of those with Alzheimer's.

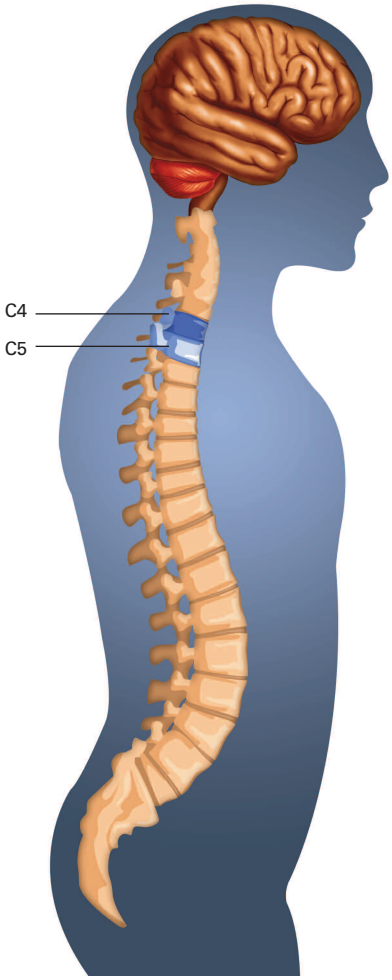
If this process promotes the disease, as the scientists believe, a drug that prevents APP from connecting to cholesterol might forestall Alzheimer's, a condition that affects up to 5 million people in the United States.

—Alisa Zapp Machalek

I like being able to decide

Medically speaking, he had injured his spinal cord between the C4 and C5 vertebrae in his neck. He could no longer move his legs, arms, hands or wrists. He eventually recovered movement in his biceps and can rotate the lower portion of his right arm.

"I was a competitive swimmer for most of my life up to the accident. It was tough," he says. "But fortunately, I had other things to rely on. Academics were as important to me as athletics. When I couldn't compete athletically anymore, I competed academically."



Duerstock injured his spinal cord between the C4 and C5 vertebrae.

He also had to learn new ways to get around, eat, dress, bathe, open doors, check e-mail, talk on the phone, take notes, study and take exams.

Throughout his hospitalization and rehabilitation, Duerstock kept up with his schoolwork and maintained his high grades.

"My teachers were amazing," he remembers. "They would send me my assignments and make photocopies of handouts while I was in the hospital, and some would visit regularly to privately tutor me."

This commitment paid off. The first time Duerstock left the hospital was to deliver his high school commencement speech—as valedictorian of his class.

After the ceremony, he had to go back to the hospital.

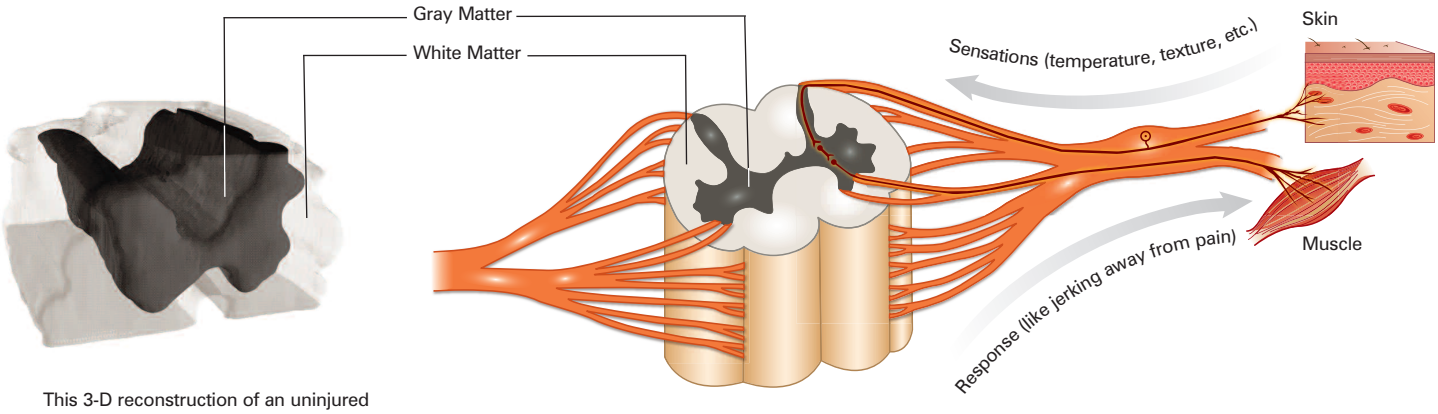
College Choice

Despite his stellar academic record, some doors were still closed to him. He'd been appointed to West Point Military Academy, "but I quickly knew that wasn't going to happen," he says. West Point has strict physical requirements for its cadets.

So Duerstock decided to attend a nearby university, Purdue, which he knew was "famous for engineering." He switched his planned major from premed to an interdisciplinary engineering program focused on biomedical engineering.

At the time, "Purdue didn't have much in the way of accommodations," he remembers. "But they were working to comply [with the recently passed Americans with Disabilities Act of 1990] and wanted to find ways to accommodate me."

what I want to research. That independence appeals to me.



This 3-D reconstruction of an uninjured section of rat spinal cord shows gray matter (dark gray) and white matter (transparent). Duerstock devised this technique to enable researchers to examine the center of the spinal cord.

BRAD DUERSTOCK

Section of Spinal Cord

Spinal nerves (orange) carry messages to and from the spinal cord.

NATIONAL INSTITUTE OF NEUROLOGICAL DISORDERS AND STROKE, NATIONAL INSTITUTES OF HEALTH

Now, as a faculty member at his alma mater more than 20 years later, he helps accommodate students with disabilities by creating assistive technology for use at home, school or work.

Investigating Injury

Duerstock first got a taste of research as a senior in college at Purdue's Center for Paralysis Research. He was fascinated by the work and went on to earn a Ph.D. in neuroscience. He now conducts his own research in areas ranging from neurotrauma to assistive technology.

"I like being able to decide what I want to research," he says. "I can look at whatever piques my interest. That independence appeals to me. It's very exciting."

A major focus of his research is on chronic (long-lasting) injuries to the spinal cord and central nervous system. What especially interests him is secondary injury.

Secondary injury is caused by the body's massive response to the initial trauma to nerves, bones and blood vessels. It includes a flood of white blood cells, inflammation, bleeding, tissue death from lack of oxygen and biochemically induced damage to nerve cells.

"There's a lot of things going on in secondary injury," Duerstock says. So many things, in fact, that "it's really hard to find the critical culprits."

Duerstock and his colleagues are hunting down these culprits using a variety of tactics. In one, they examine healthy and damaged nerve cells under a microscope to identify anatomical changes. Several years ago, they devised a way to computationally combine the images from many microscope slides to create a 3-D view of specific cells and molecules at the center of the spinal cord, where the most severe injuries occur.

They also look for molecules that cause or reveal secondary injury. Right now, they have their eyes on acrolein—the substance you smell when cooking oil burns. Acrolein increases dramatically after a spinal cord injury and fatally damages the nerves it touches. So it could be a major player in secondary injury.

In their search for treatments that lessen or repair nerve damage—or that stimulate the growth of new, healthy nerves—Duerstock and others are investigating a compound called polyethylene glycol or PEG, which is known to seal ruptured nerve cell membranes. In animal studies of spinal cord injury, PEG significantly reduced tissue damage and improved the animals' ability to move.

Duerstock realizes that his research could ultimately help not only the estimated 1.3 million people in the United States with spinal cord injuries, but also those with nerve damage from traumatic brain injury, diabetes, infections or neurodegenerative diseases like Alzheimer's and Parkinson's.

"The sense of discovery and the impact on others are big motivations for me," he says. "Being a researcher, you might have a broader impact on society than you would as a practicing physician."

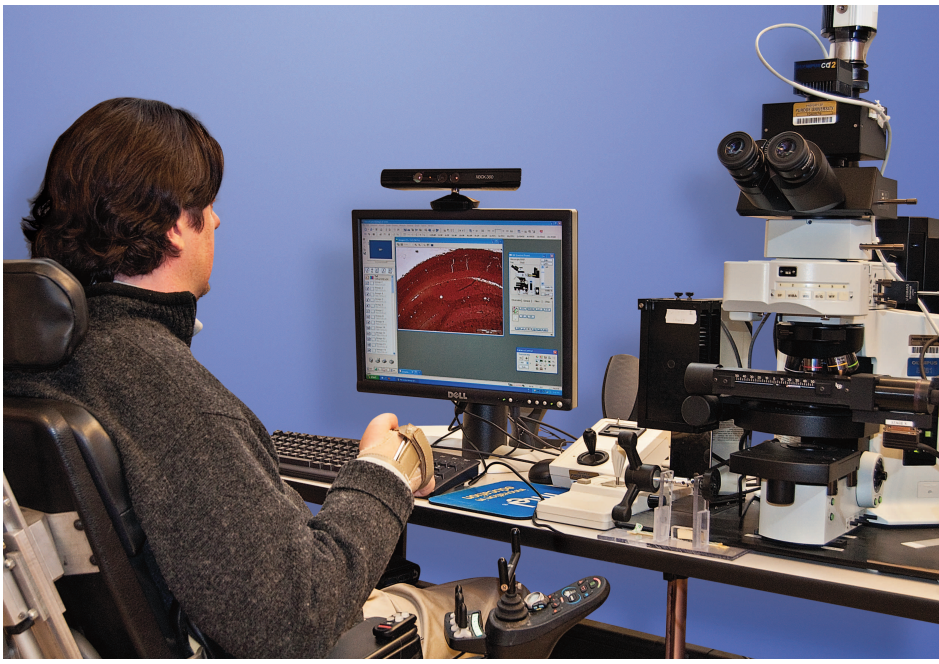
Science needs people from different backgrounds to

A Wider Scope

Duerstock always strives to be self-sufficient, conducting experiments and gathering data himself rather than relying on others in the lab. Often, that means creating new tools—like the accessible microscope he calls AccessScope.

"The light microscope is one of the fundamental pieces of equipment used in a biomedical lab. Having that tool available is critically important," he says. "AccessScope has allowed me to work for hours independently."

Duerstock started building AccessScope when he was a postdoctoral researcher. Although designed for people with upper-limb mobility impairments like his, it also turned out to help people with limited vision.



ANDREW HANCOCK, PURDUE UNIVERSITY

AccessScope is a high-tech light microscope that Duerstock modified to be accessible for people with limited hand and arm mobility, wheelchair users and those with impaired vision.

Devices that make life easier for people with disabilities often benefit others. Sidewalk ramps were created for wheelchair users, but they also help people pushing strollers, wheeling luggage or riding bicycles.

"Microscopes require you to perch and lean forward to peer into the eyepieces," Duerstock explains. "That's not something easily achieved by a wheelchair user." Nor is it easy for people with vision loss, he adds.

So, instead of using eyepieces, AccessScope displays images on a computer screen, where they can easily be enlarged to help all types of users.

Users who can't see the instrument readouts can use third-party screen-reading software to hear them.

Those with limited hand control due to paralysis, arthritis, carpal tunnel syndrome or other motor impairments can control an accessible slide loader to automatically place slides on the microscope stage. They can then adjust the microscope using a variety of methods, including keyboard, mouse or trackball.

Duerstock is also working to make AccessScope available to others remotely through his networking site. He envisions users logging in through a Web browser and performing microscopy from anywhere.

As Duerstock points out, assistive technology frequently has broader benefits than originally intended.

"Often what can be considered good assistive technology simply means creating a device that excels in user design or usability," he says.

look at problems in different ways.

IAS—It's About Science

Duerstock's most ambitious and far-reaching project yet is the $2 million Institute for Accessible Science, or IAS.

Based at Purdue and begun in 2010, it includes a fully accessible lab and the IAShub.org online networking site.

The hub is designed for people interested in improving accessibility for those pursuing science careers. It offers something Duerstock says he didn't have right after his injury—connection, inspiration and support from like-minded people. It serves as a virtual community where students, scientists, parents and teachers can share their experiences with overcoming obstacles.

The hub includes helpful articles and Web sites, participant profiles, a discussion forum and a blog. It also lists funding ideas for scientists who bring students with disabilities into their labs.

"[Mentoring such students] might take a little more work, but the funding and technologies are out there," he says. "And inclusion really has long-term benefits, not only for the individual with a disability, but also in bringing a greater diversity of people into science who have different perspectives to offer. Science needs individuals from different backgrounds to look at problems in different ways."

DO-IT for Science

Performing bypass surgery using sheep hearts.
Touring Microsoft's headquarters. Working in a forensics lab.

High school students in the DO-IT Scholars program do these things and more during a 2-week sneak peek of college life at the University of Washington in Seattle.

DO-IT Scholars is a college-prep program in Washington state for students interested in careers in science, technology, engineering or math. But it's also much more.

DO-IT stands for Disabilities, Opportunities, Internetworking, and Technology. As you'll learn from the many videos posted on its site (http://www.uw.edu/doit), DO-IT Scholars describe it using words like fun, connection, learning and independence.

DO-IT Scholars have vision, hearing or mobility impairment; cerebral palsy; autism; or some other disability.

The 3-year program provides computer hardware and software, including any necessary assistive devices. It trains scholars to use technology to accomplish things they might never have thought possible.

The program hooks its participants into a broad, supportive and empowered network of other students with disabilities. It nurtures leadership skills, self-advocacy and lifelong friendships.

Many alumni continue to be involved in the program years after they've graduated by serving as mentors for younger scholars.

The DO-IT Scholars program began in 1993. It's been so successful that programs in Japan and South Korea have used it as a model for some of their own activities. —*Alisa Zapp Machalek*

I'd like to think that after I leave the world, I've

Access ABILity

To create the lab—dubbed the Accessible Biomedical Immersion Laboratory, or ABIL (sounds like "able")—Duerstock recruited an interdisciplinary team.

Engineers, ergonomics specialists, scientists, architectural designers and others renovated a standard "wet" lab to accommodate the needs and safety concerns of wheelchair users, people with vision loss and others who need to work in the lab.

Among ABIL's modifications:

- Wider doors and aisles so wheelchair users can enter and turn around without knocking into delicate equipment.
- Lower lab benches for common tasks like pipetting, creating slides and using microscopes.
- Lower, shallower sinks so people in wheelchairs can see and reach to the bottom.
- Faucets mounted on the side rather than the back of sinks so they are easier to reach. Ditto for the spray nozzle and distilled water dispenser.
- Easy-to-flip levers instead of round knobs that are harder to grasp.
- Emergency shower controls and eye wash centers adjusted for wheelchair users and easier for people with visual impairments to locate.

Other issues are harder to address.

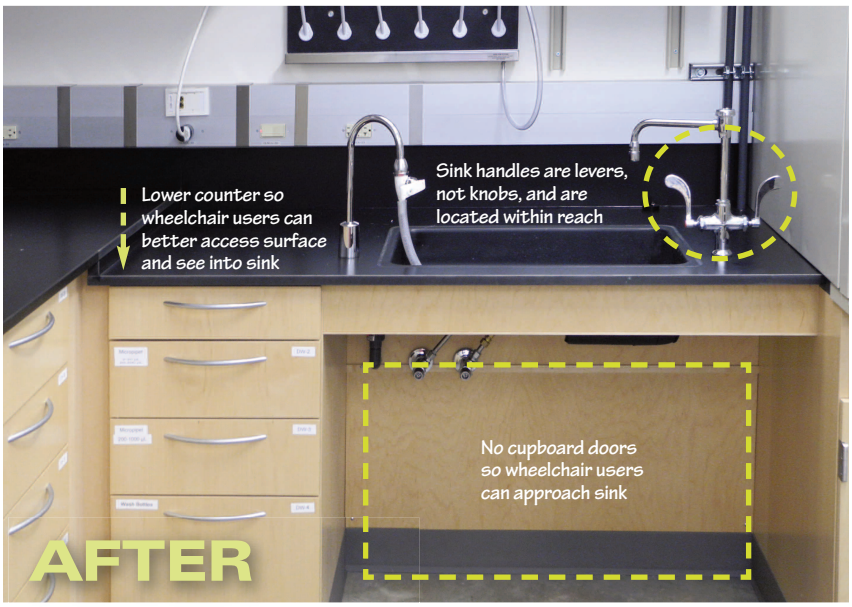
"Wheelchair users can't back away from a chemical spill easily or quickly," Duerstock points out. "Plus, you have a lap." Spills into the lap can go unnoticed for a while if you've lost feeling in your legs.

ABIL's first big test will come from a group of undergraduate students with mobility or vision limitations. Up to six students will use the lab and devise some of their own modifications while collaborating on research projects with Purdue scientists.

At the time of this writing, the students hadn't arrived yet. To find out what they had to say about their experience at ABIL, check online at http://publications.nigms.nih.gov/findings.

BRAD DUERSTOCK

When Duerstock looks at a laboratory, he easily envisions changes that would make the space more accessible to wheelchair users.



BRAD DUERSTOCK

improved it in some small way.

Bringing Lessons Home

Duerstock hasn't brought architectural innovations just to the lab. In 2001, he also designed his own accessible home.

"Architectural design interests me a lot," says Duerstock. "Before using a wheelchair, I had never thought much about it. But afterwards, when everything became inaccessible to me, one of my earliest desires was to be able to control my environment—to create my own space."

He designed each aspect of the house—from the thickness of the carpet to the automatic openers on interior doors—to make his life easier and more efficient.

He lives in the home with his wife, Li Hwa, and their dog, Luke, and cat, Xiao Hei.

Luke, a yellow Labrador retriever, is another sort of assistive technology. Duerstock got him several years ago from the Indiana Canine Assistant Network, an organization that arranges for prison inmates to train assistive dogs and then matches the dogs with owners.

For Duerstock, Luke is a big help opening sliding doors (he tugs on a rope tied around the handle), carrying things and picking up objects Duerstock drops.

"That used to be a big frustration—if I dropped my pen on the floor, it might as well have been on the moon, because I wasn't going to get it unless I had some assistance," says Duerstock.

In return, Duerstock devised some creative ways to give Luke the attention dogs crave. He plays fetch with Luke using a remote-controlled ball thrower, and he modified a candy dispenser to dole out kibble treats.

Occasionally, he brings Luke to work for extra petting—although he has to be careful, because the lab is not yet accessible for dogs with uncontrollably wagging tails.

While Duerstock doesn't know if there will be a cure for spinal cord injury and paralysis in his lifetime, he does hope to advance the field.

In the meantime, his assistive technology innovations and leadership of the IAS promise to make it easier for people with disabilities to work in labs and make discoveries of their own.

"I like knowing that what I do can ultimately impact others," Duerstock says. "That is very satisfying to me. I'd like to think that after I leave the world, I've improved it in some small way." ● ● ●

FIND MORE @

See Duerstock and Luke in action several times in a video from the Indiana Canine Assistant Network at http://tinyurl.com/caninenet

Check out the networking site Duerstock and others created at http://iashub.org

Read Duerstock's tips for building an accessible and energy-efficient home at http://web.ics.purdue.edu/~bsd/building.html

Learn how scientists can receive funding to support students with disabilities in their labs at http://www.nigms.nih.gov/Research/Mechanisms/PromoteDiversity.htm

How Bacteria Defend Themselves Against Fluoride

For decades, people have prevented tooth decay using fluoride, which is found naturally in the environment and added to toothpaste, mouthwash and public water supplies. Fluoride works by strengthening tooth enamel and attacking the bacteria that cause cavities.

But scientists have recently discovered that many bacteria—including those that decay teeth—can defend themselves against fluoride.

A research team led by Ronald Breaker of Yale University in New Haven, Connecticut, found that bacteria use a bit of RNA called a riboswitch to sense and respond to high levels of fluoride. When fluoride attaches to it, the riboswitch activates specific genes that appear to encode proteins called fluoride transporters. The researchers suspect that bacteria use these transporters to rid themselves of fluoride, avoiding its effects.

To parry this bacterial defense system, scientists could try to block the fluoride transporters or disable the fluoride riboswitch. Either way, the goal would be to stop bacteria from escaping a fluoride build-up.
—Amber Dance

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